Sociality I:
Fish Communication

FISH 310

Cartoon by Victoria Roberts

How and **why** do fishes communicate?

- Aggression, cooperation, competition, reproduction, etc.
- Communication between individuals of the same species = **intraspecific** interactions
- Communication between different species = **interspecific** interactions
- Communication requires the **signal** to stand out from the background
- Signals can be combined to increase effect or decrease ambiguity

Cartoon by Victoria Roberts

Today's Roadmap

1. Visual Communication
2. Acoustic Communication
3. Chemical Communication
4. Tactile Communication
5. Electrical Communication

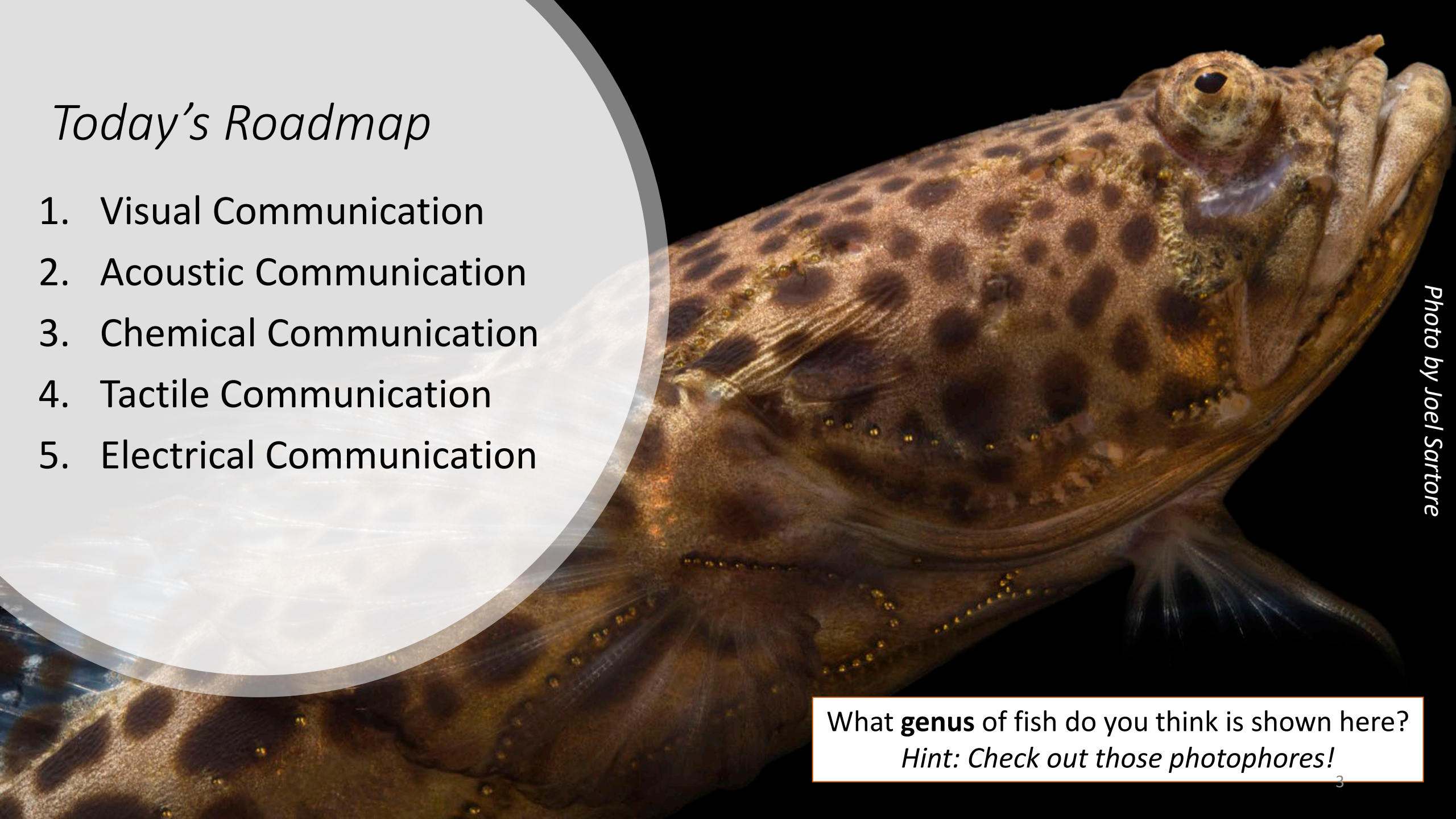
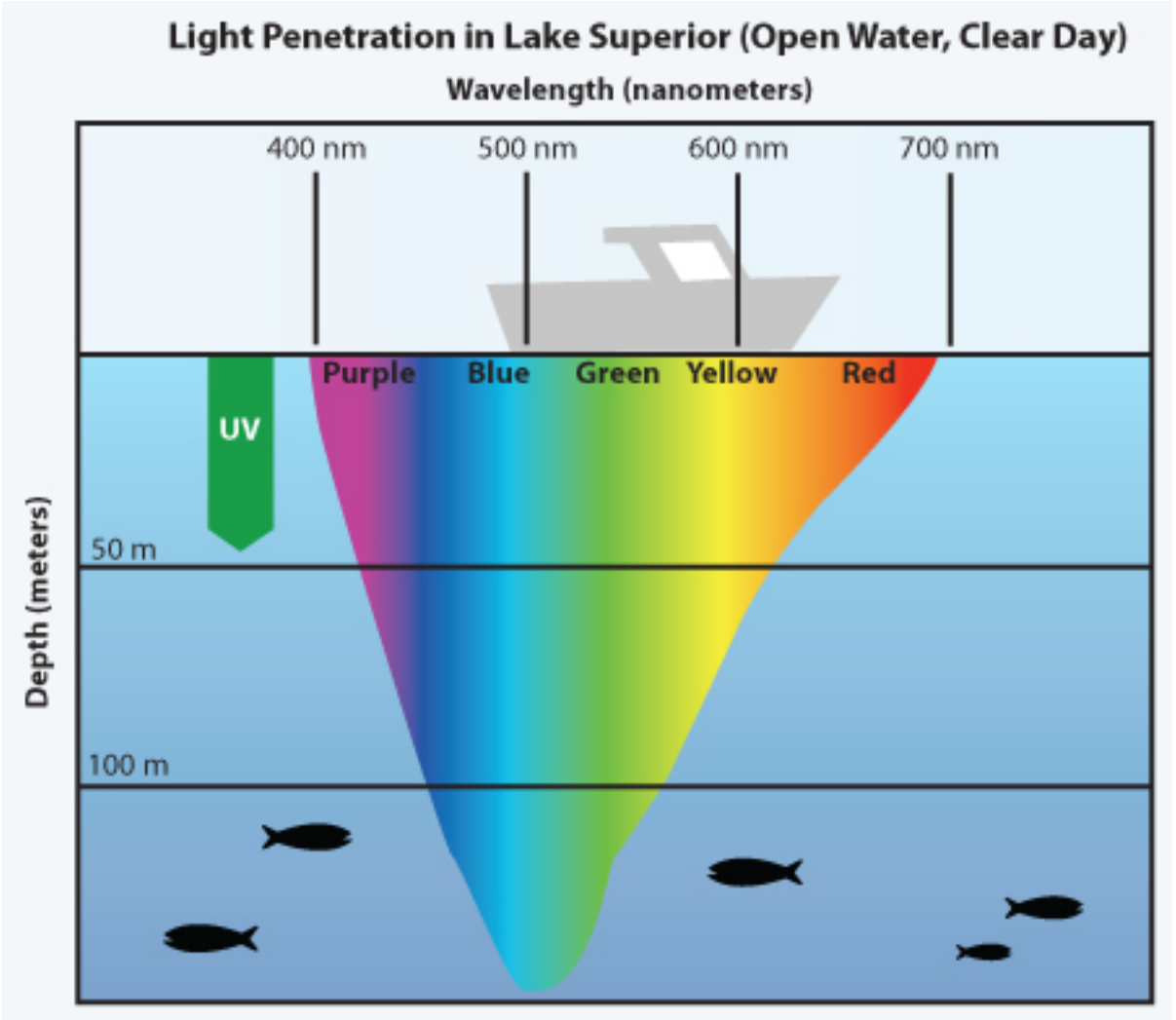


Photo by Joel Sartore

What **genus** of fish do you think is shown here?
Hint: Check out those photophores!

Visual Communication

- **Coloration** dependent on **hue** (wavelength mixtures), **saturation** (wavelength purity), and **brightness** (light intensity)
- Colors used in static or dynamic displays:
  - **Static coloration** acts as "identification badge," informs about the species, sex (sexual dimorphism!), reproductive condition, or age
  - **Dynamic coloration:**
    - Rapid exposure of colored, previously hidden structures via movement of fins, mouth, operculum, etc.
    - Changes in color



Visible colors of light penetrate differently into water. **Longer wavelengths such as red** are absorbed at a shallower depth than **shorter wavelengths such as blue**, which penetrates to a deeper depth. Image courtesy of The University of Minnesota Sea Grant Program

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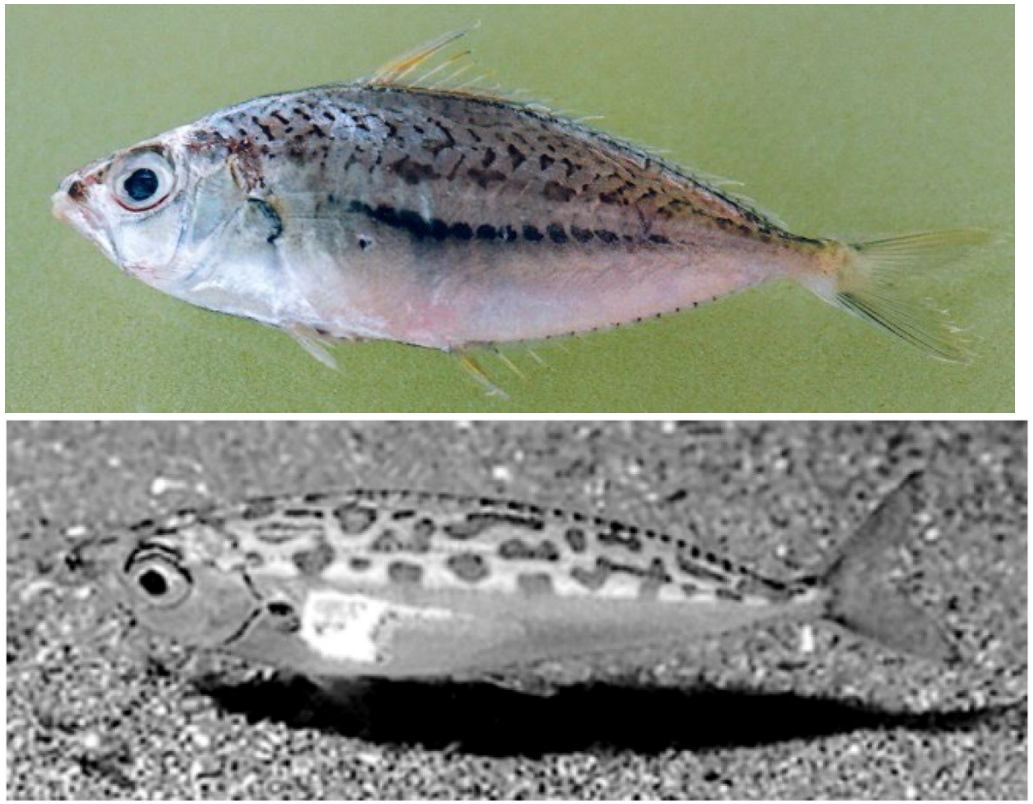

Figure 22.1

A nighttime photograph of a male ponyfish, *Leiognathus elongatus*, emitting light from its specialized circumesophageal light organ. The light display is the bright rectangular area just posterior of the pectoral fin. Light emission involves a complex series of structures and behaviors including bacterial light production, internal reflection, and transmission through a muscular shutter in a transparent section of the body wall. Four different light displays have been described in which duration and intensity of light emission are varied. From Sasaki et al. (2003), used with permission.

“The diversity of colors in fishes is nearly unlimited.”

- Chromatophores (pigment cells) in dermis contain carotenoids and other compounds that reflect **yellow**, **orange**, and **red**
- **Achromatic** elements = black & white structures
  - **Black** from moving **melanin** granules within melanophores; dispersed melanin in a cell looks darker, concentrated melanin (@ center of cell) looks lighter
  - **White** coloration from **guanine** crystals (in leucophores and iridophores) that reflect light
- **Greens**, **blues**, **violets** = structural colors: light refracted or reflected by layers of skin and scales, color depends on thickness of the layers relative to wavelength of the light

Changing Colors

- Why?
  - Advertise changes in behavior (agonistic interactions, breeding behavior)
  - Hide from predators
- Short-term color change due to nervous system control
- Long-term change (ontogenetic, seasonal breeding coloration) due to hormones

Visual Threat Displays & Ritualized Combat

May involve **lateral displays**: 2 fish swim in place with fins spread, oriented either parallel or antiparallel (head to tail) (Fig. 22.2) and may push water toward each other to incorporate tactile communication;

or **frontal displays**: fish facing each other head on (may even grab each other)

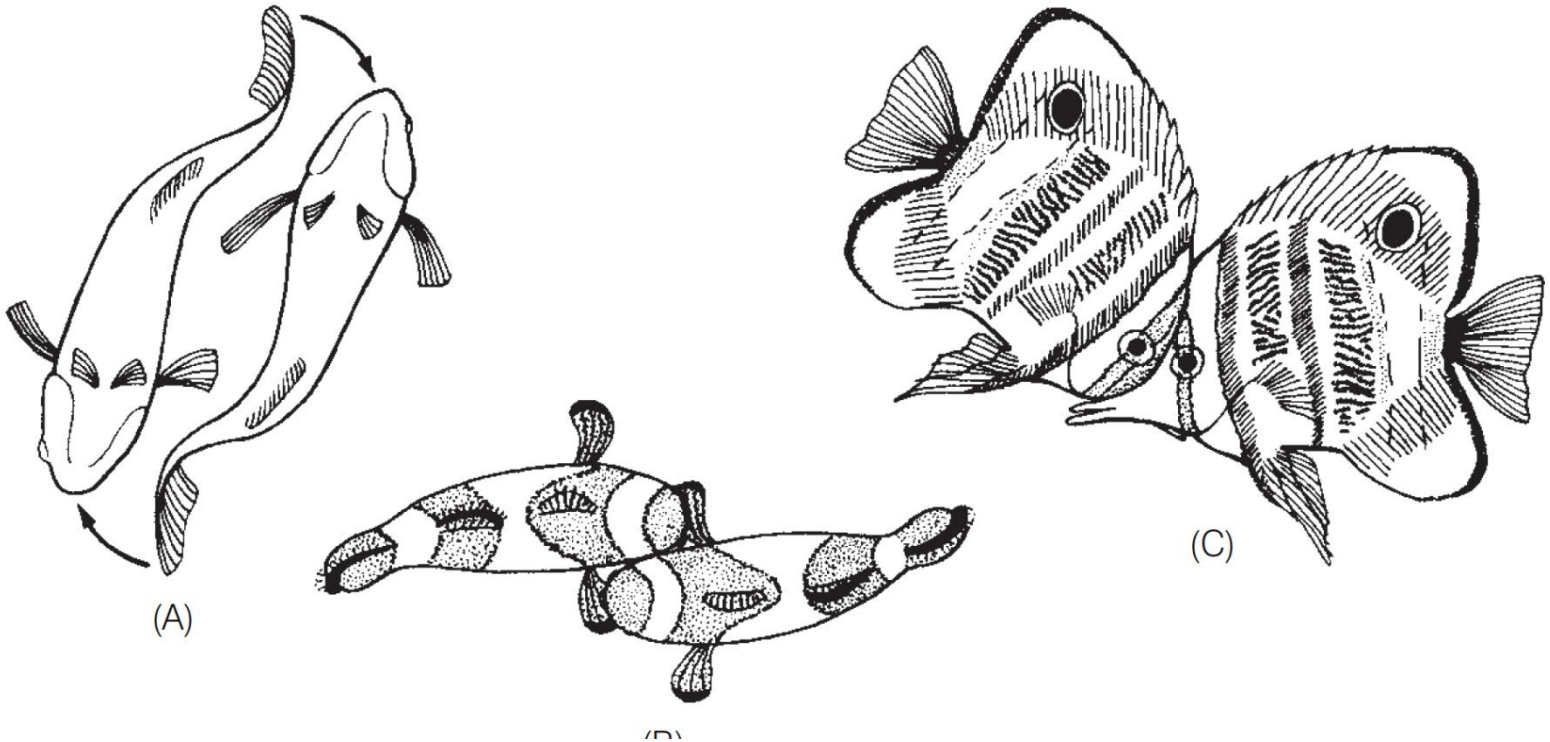

Figure 22.2

Lateral and frontal displays in fishes. During agonistic interactions, fish may line up parallel, antiparallel, or head-to-head and remain stationary, spread fins or operculae, change colors, and swim in place or circle one another. (A) Typical swimming-in-place lateral display when water currents (arrows) are directed at the head of the opponent, as happens in many cichlids. (B) Lateral display in the clownfish, *Amphiprion*, during which individuals strike each other with their pectoral fins. (C) Head-to-head pushing in the butterflyfish, *Chelmon rostratus.* (A) after Chiszar (1978); (B, C) after Eibl-Eibesfeldt (1970).

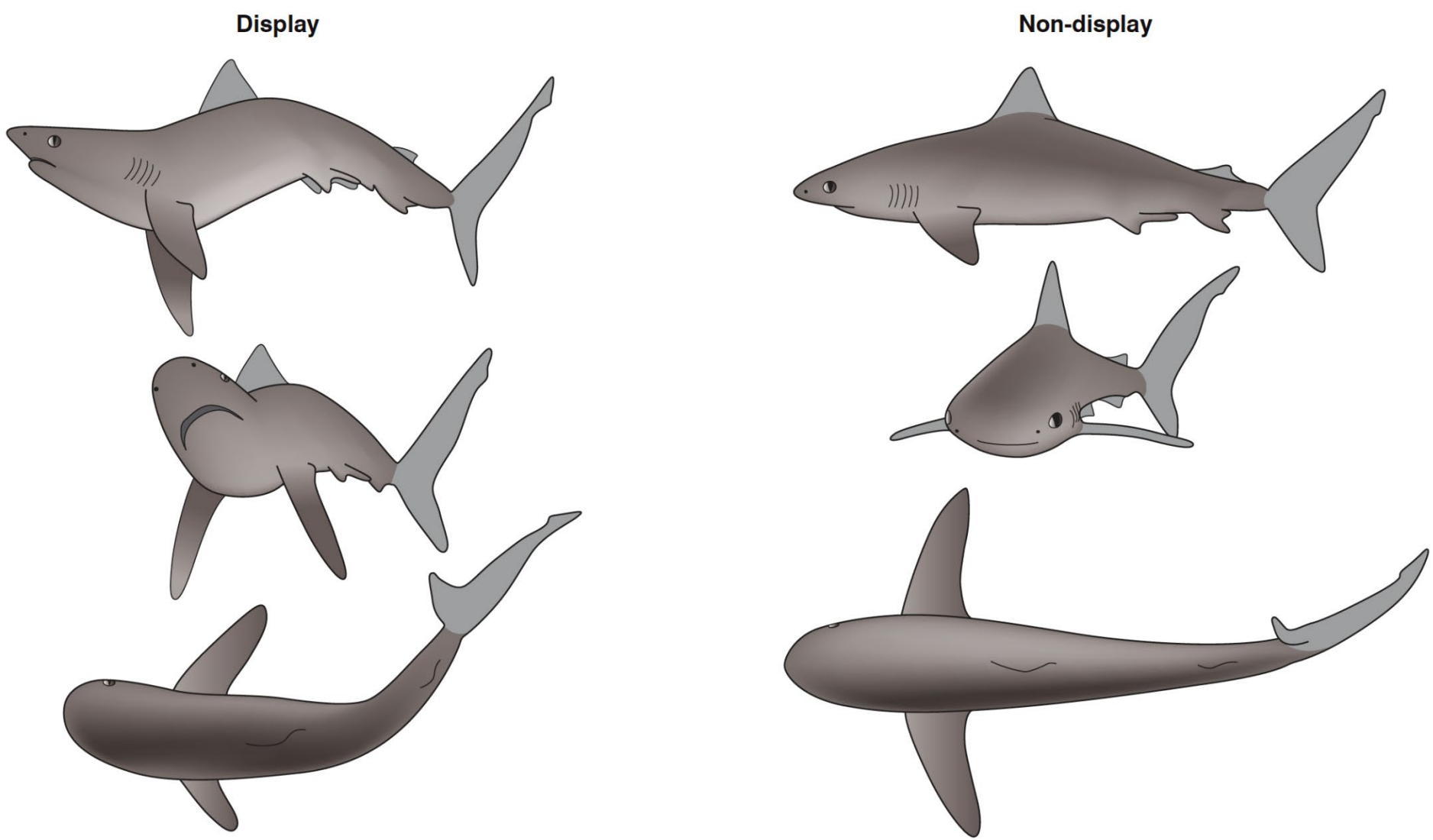

Figure 22.3

Exaggerated swimming display of the Gray Reef Shark, *Carcharhinus amblyrhynchos*. When approached by a diver or another shark or a small submarine, or when competing for food, Gray Sharks lift the snout, arch the back, lower the pectoral fins, and swim in a tense, exaggerated manner (exaggerated postures shown on left, comparatively normal swimming postures on right). If the intrusion continues, the displaying shark may attack the intruder. Similar displays, without attacks, have been observed in Galàpagos, Silky, Lemon, and Bonnethead sharks, and a Bull Shark performed exaggerated S-turn swimming before attacking a small boat that had been following it (S. Gruber, pers. comm.). After Johnson and Nelson (1973), used with permission.

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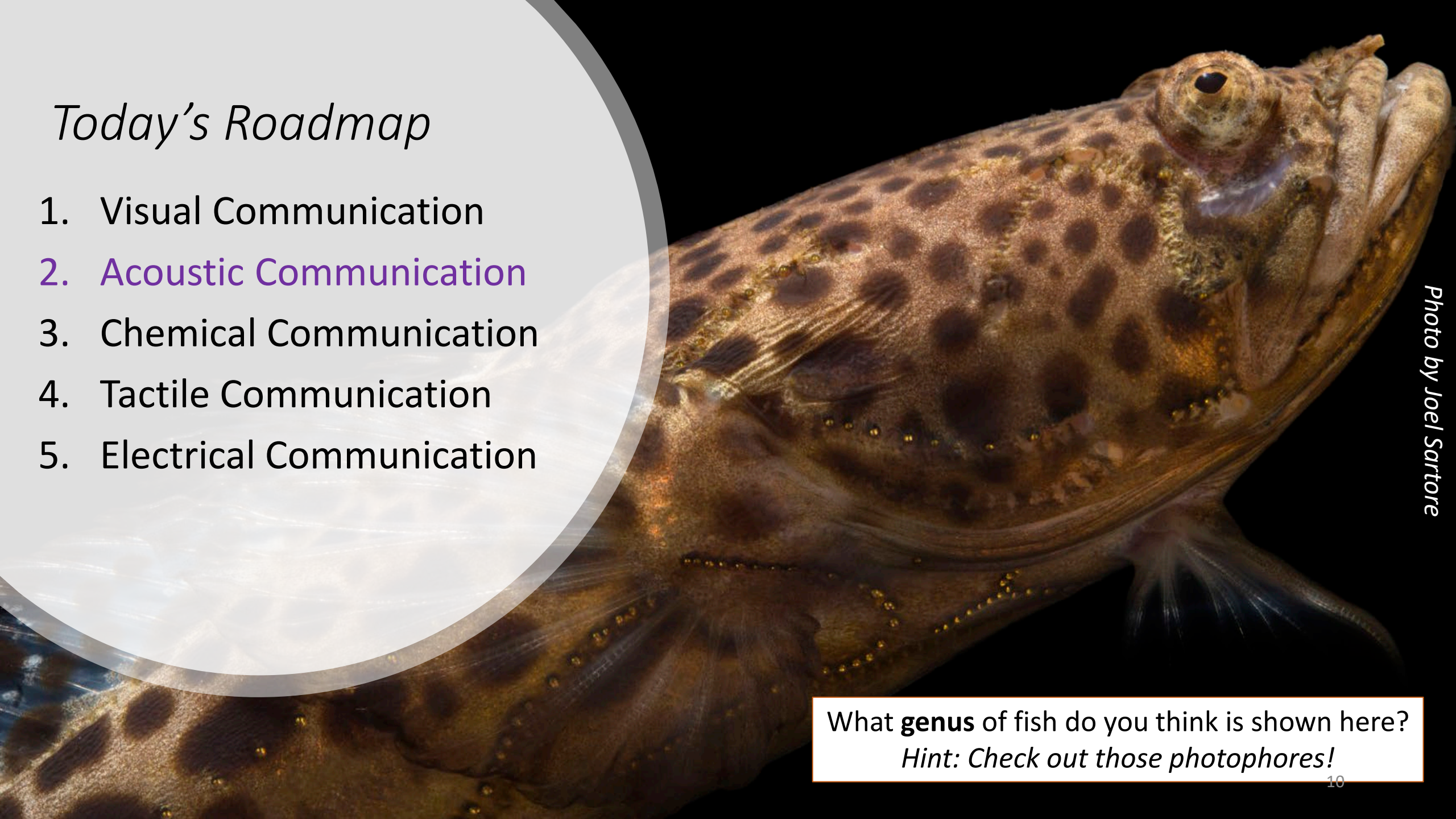

Photo by Joel Sartore

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Hint: Check out those photophores!

Acoustic Communication

- > 50 families of fishes, with 4 common types of communication:
  1. **prey responses to being startled or handled by predators ("stay away" and "release" signals)**

Leptocottus armatus
Pacific Staghorn Sculpin

Acoustic Communication

- > 50 families of fishes, with 4 common types of communication:
  1. prey responses to being startled or handled by predators (“stay away” and “release” signals)
  2. **mate attraction, arousal, approach, or coordination sounds**

Porichthys notatus
Plainfin Midshipman

Acoustic Communication

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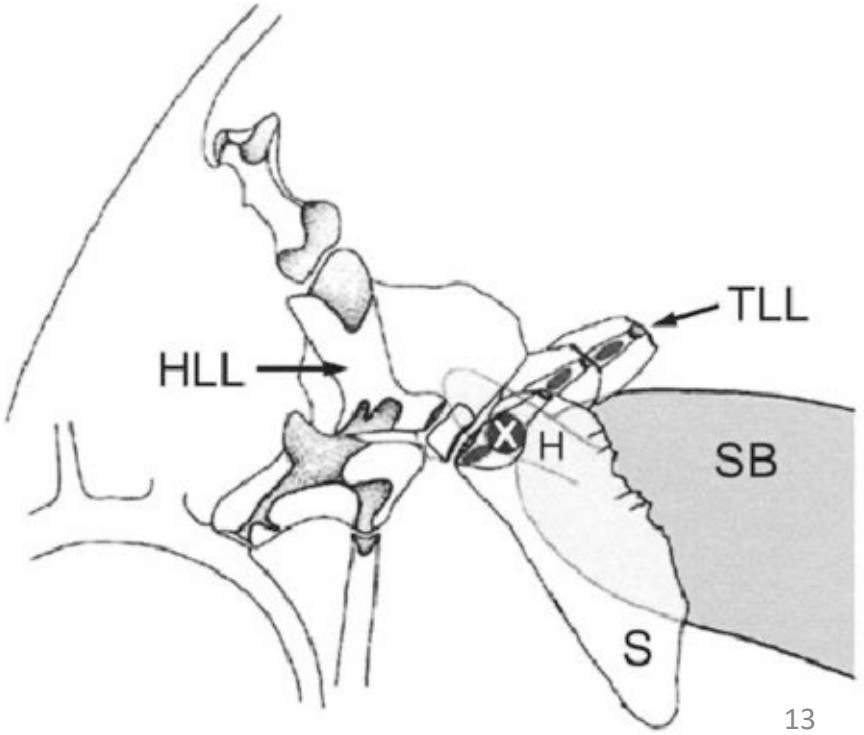
  2. mate attraction, arousal, approach, or coordination sounds
  3. **agonistic interactions with competitors for mates and resources (“stay away” signals)**

Laterophysic system in butterflyfishes of the genus *Chaetodon* located at the junction of the trunk lateral line (TLL) and head lateral line (HLL) canal systems
Laterophysic connection formed by gas-filled horns (H) that extend from the anterior swim bladder (SB) and a small tympanum (dark circle and X) on the medial edge of the canal in the supracleithrum bone (S)
Swim bladder horns also project towards the otic capsule.
Figure modified from Webb and Smith (2000)



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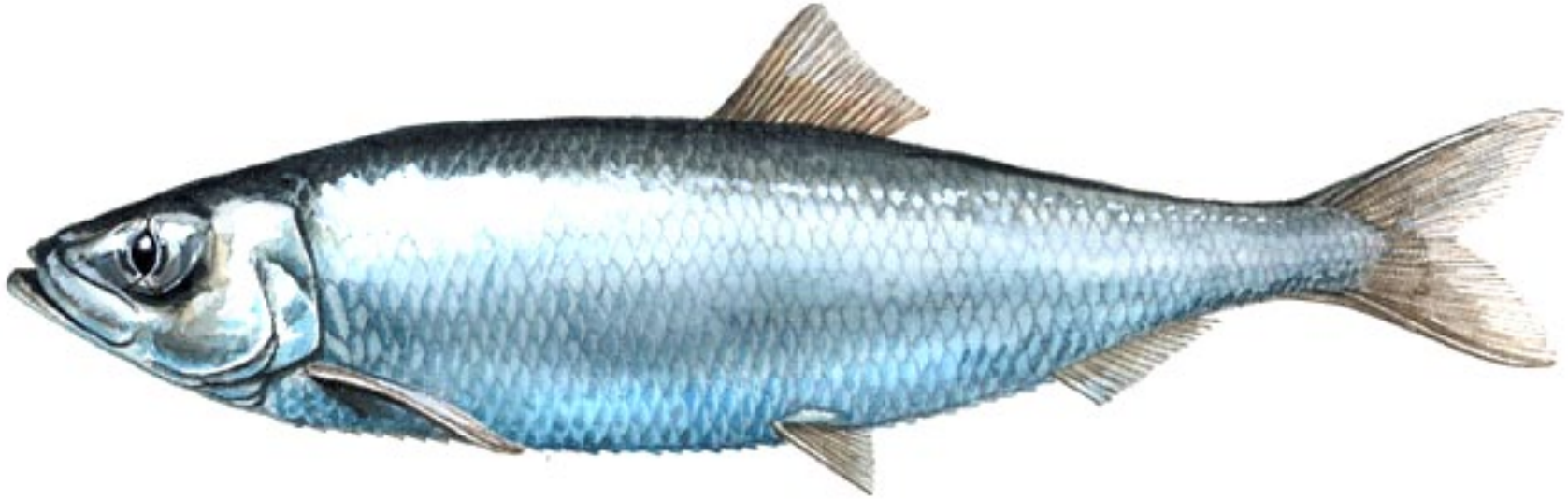
  2. mate attraction, arousal, approach, or coordination sounds
  3. agonistic interactions with competitors for mates and resources (“stay away” signals)
  4. **attraction of shoal mates**



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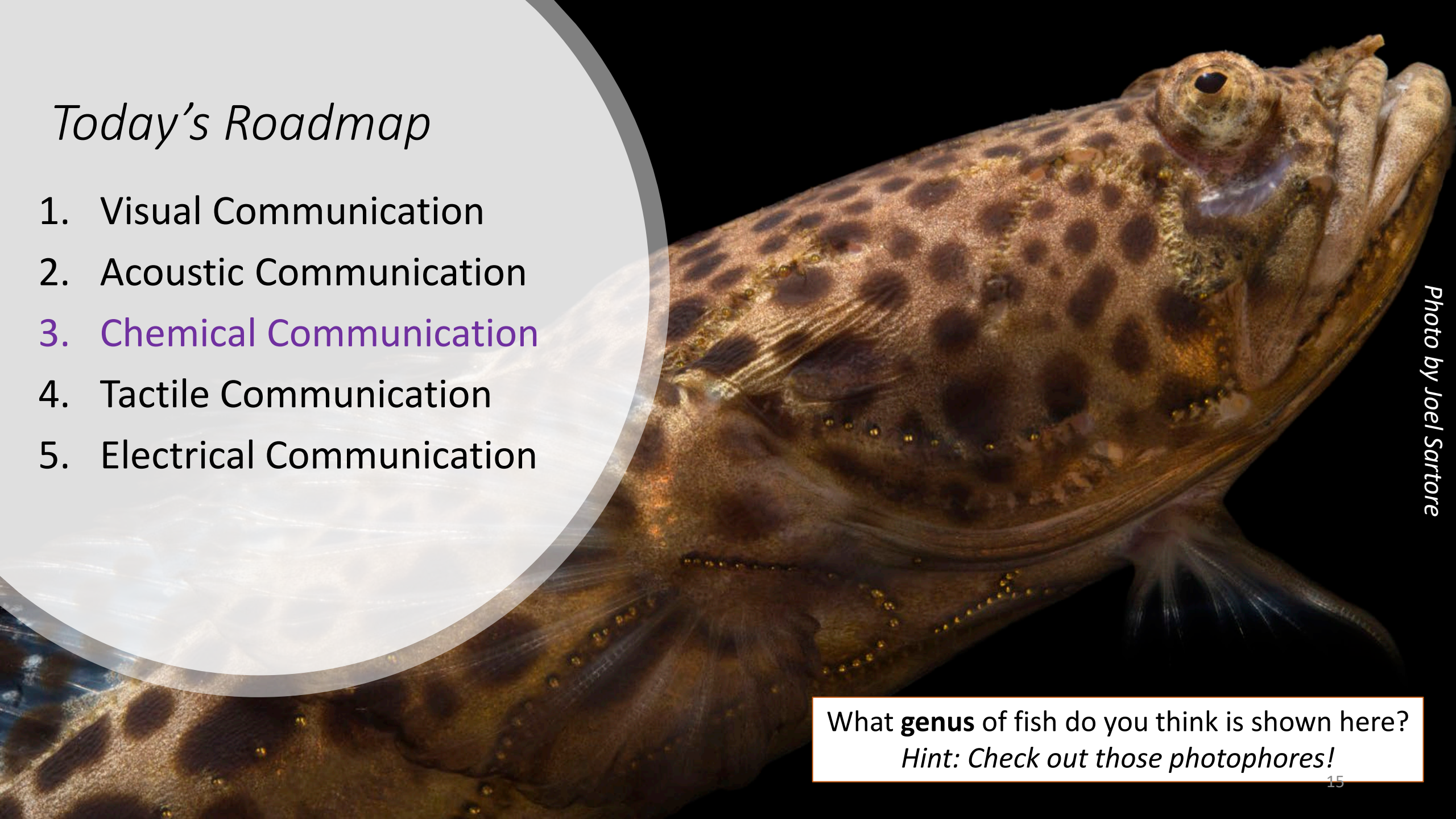

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Chemical Communication

- **Pheromones**= chemicals secreted by one fish and detected by conspecifics (via **gustation** or **olfaction**), producing a particular behavioral or developmental response in the receiving individual

Typhlogobius californiensis
Blind Goby

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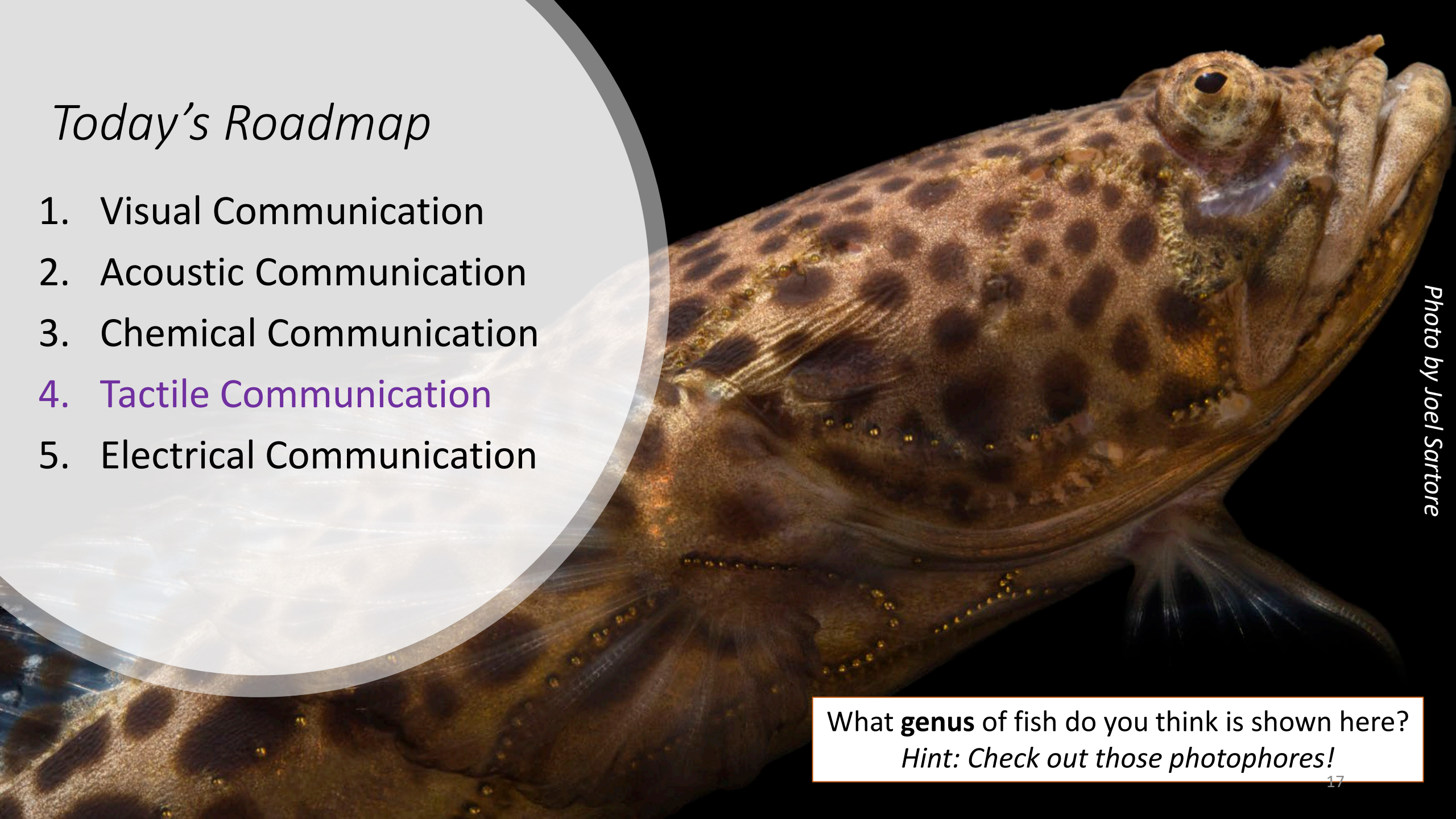

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Tactile Communication

- May be agonistic, for reproduction, for parental care, and other functions

Nuptial tubercles of a bluehead chub

Barbels of a catfish

Which catfish species is this?

Parental touching in Osteoglossidae

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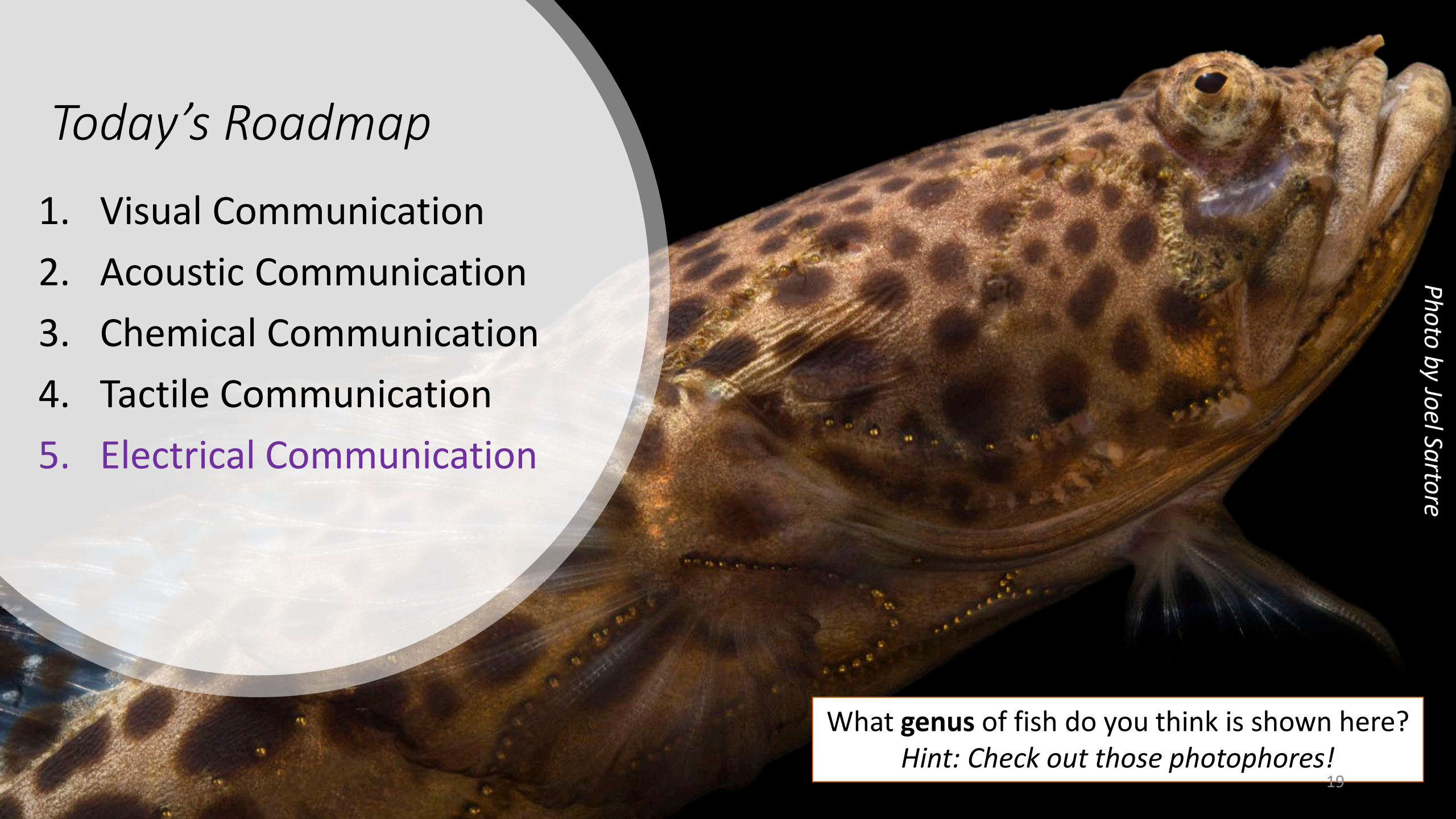

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Electrical communication

- Electric organ discharge (EOD)
- Can modify EOD amplitude, frequency, pulse length, or interpulse length of its discharge, EOD fundamental frequency or peak power frequency
- Provides information about species, sex, size, maturational and motivational state, location, distance, and individual identification
- Jamming Avoidance Response
- Purposeful jamming

Apteronotus leptorhynchus

Brown Ghost Knifefish